Human Health Impacts from Herbicide Use, Malheur National Forest

Introduction

This section has been updated to reflect 1) updated risk assessment information for imazapyr, picloram and triclopyr and 2) additional analysis for herbicide application rates and methods that are specific to this project and incorporate project design features, 3) changes to project design features in response to public comments and 4) updated risk assessment worksheets that allows examination of additional human health exposure scenarios. The DEIS discussed risks associated with exposure to NPE surfactants. These risks have been eliminated because this this class of surfactant would no longer be approved for this project in any alternative (PDF F1).

This chapter summarizes information from the R6 2005 FEIS and accompanying Appendix Q: Human Health Risk Assessment, which detailed the potential for health effects from non-herbicide treatments as well as the use of 10 of the herbicides proposed for this project, and is incorporated by reference in this EIS. Herbicide active ingredients, metabolites, inert ingredients, and adjuvants, and people with particular herbicide sensitivity were addressed. The R6 2005 ROD adopted standards to minimize herbicide exposures of concern to workers and the public based on the human health risk assessments. The herbicide risk assessments are updated on an ongoing basis; the glyphosate, imazapyr, picloram and triclopyr risk assessments were updated in 2011.

This chapter also discusses the proposal to add a new herbicide, aminopyralid. Aminopyralid poses low risk to human health and compares favorably to the herbicides approved in the R6 2005 ROD (see table 18, chapter 3.1.2 in this FEIS). The Aminopyralid Risk Assessment (SERA, 2007) is the primary source of toxicological information.

Hazards normally encountered while working in the woods (strains, sprains, falls) are possible during herbicide and non-herbicide invasive plant treatment operations. Such hazards are mitigated through worker compliance with occupational health and safety standards and are not a significant issue for this project-level analysis. Non-herbicide treatments are routinely implemented on the Malheur National Forest and no extraordinary circumstances have been found requiring the need for additional human health analysis for manual, mechanical, biological or cultural treatments. Although the action alternatives may rely on varying levels of non-herbicide treatments, the difference between the exposures to occupational hazards are negligible. For more information on potential effects of non-herbicide treatments, see the R6 2005 FEIS chapter 4.5.

The use of herbicide in the action alternatives would be according to label requirements, with further direction in Malheur National Forest LRMP as amended by the R6 2005 ROD for standards and project design features associated with the project.

The risk assessments and project specific risk assessment worksheets quantify expected exposures and calculate hazard quotients. These worksheets provide a range of values (lower, central and upper) rather than rely on a single estimate. The upper exposure estimates are based on the maximum estimate for every exposure factor that is considered, which is very unlikely to occur in our operations (e.g. maximum application volume, maximum concentration in field solution, maximum volume of a spill, maximum residue rates on food items, maximum exposure rates, maximum hours worked). The upper exposure estimates are not reflective of the way herbicides would be used in this project and the probability of maximum exposures occurring is very low. Thus, the central and lower estimates provide more realistic risk assessment results.   Slight exceedances of hazard quotients greater than 1 could cause clinically detectable physiologic changes, but are unlikely to produce any human health symptoms detectable by a person.

The risk assessments and risk assessment worksheets consider potential impacts to children, women of child-bearing age, and men. In some cases, the reference dose (Rfd) varies between these groups.

Even considering central or lower HQ estimates, many of the exposure scenarios for the general public are implausible or extremely conservative.

Regulatory Framework and Compliance

The Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) established the United States system of pesticide regulation to protect applicators, consumers and the environment. It is administered by the Environmental Protection Agency and the appropriate environmental agencies of the respective states. The Federal Insecticide, Fungicide, and Rodenticide Act requires registration for all herbicides, after extensive testing, to evaluate whether a pesticide has the potential to cause adverse effects on humans, wildlife, fish, and plants, including endangered species and non-target organisms, as well as possible contamination of surface water or ground water from leaching, runoff, and spray drift.

When registered, a label is created to instruct the applicator on the proper usage of the material and required personal protective equipment. The EPA also must approve the language that appears on each pesticide label and the product can only be used legally according to the directions on the labeling accompanying it at the time of sale.

The Forest Service is authorized by FIFRA and the Cooperative Forestry Assistance Act to use pesticides for multiple-use resource management and maintenance of the quality of the environment as long as the actions comply with the National Environmental Policy Act and the Council on Environmental Quality regulations. Forest Service Manual (FSM 2150) and Forest Service Handbook (FSH 2109) provide direction on safe use of pesticides, including direction on storage and transport, and development of safety plans and emergency spill plans.

In addition to label requirements and direction contained in FSM/FSH, the Forest LRMP as amended by the R6 2005 ROD, programmatically approves the use of certain herbicides and adopted standards to minimize herbicide exposures of concern to workers and the public. See table 1 in chapter 1.7 for a list of these standards and chapter 3.1.2 for risk assessment terminology.

All alternatives comply with standards, policies, and laws aimed at protecting worker safety and public health. None of the alternatives would result in disproportionate impacts to low income or minority group.

Affected Environment

The Malheur National Forest lies in a relatively remote part of Oregon, however people live near, spend time in, work in, or depend on forest products from the Malheur National Forest (Forest). Some dispersed and developed recreation areas (trailheads, campgrounds, picnic areas, recreation sites) and traditional gathering and special forest product collection areas currently occur in or near the vicinity of invasive plant sites (please see chapters 3.3, 3.9 and 3.10 for more information). People engaged in forest activities could potentially be inadvertently exposed to herbicides from treatment of invasive plants in or near these areas. Hunting is by far the greatest use on the Forest (chapter 3.9).

A variety of mushrooms, berries, roots, and herbs, some of which have cultural importance to traditional gatherers, occur on the Forest. Cultural plants are used for food and baskets and traditional gathering is essential to the maintenance of tribal traditions and culture. Gathering is also economically important. Gatherers return to the accustomed gathering areas of their ancestors to tend and harvest plants to be used for traditional purposes.

The Forest also issues permits for special forest products, such as firewood gathering. The possibility of herbicide exposure may be greater for people gathering forest products than the general public. Firewood gathering often occurs on disturbed roadsides that also contain invasive plants.

Invasive plant infested sites are scattered throughout the Malheur National Forest and occupy about 0.1 percent of the land area within the Forest. Invasive plant treatments on the Forest are implemented through Forest Service contracts or in partnership with county operations. Applicators are generally from the communities in and around the Forest, are licensed by the State of Oregon and well-trained in safe herbicide application and transportation practices. Licensed applicators are required to take ongoing training in order to remain certified (ODA website http://www.oregon.gov/ODA/PEST/pages/licensing_index.aspx).

The Malheur National Forest has several formal agreements for use of drinking water. The Water Resources section lists municipal watersheds, springs, and well intakes with formal agreements and the extent of invasive plants mapped within or near these areas.

Environmental Consequences

Worker Herbicide Exposure Analysis

The risk assessments include analysis for both workers and the general public. This section focuses on the risks to herbicide applicators. Herbicide applicators are more likely than the general public to be exposed to herbicides, and may handle undiluted herbicide concentrate during mixing and loading. In routine broadcast and spot applications, workers may contact and internalize herbicides mainly through exposed skin, but also through the eyes, mouth, nose or lungs. Worker exposure is influenced by the application rate selected for the herbicide, the number of hours worked per day, the acres treated per hour, the wearing of personal protective equipment (PPE), and variability in human dermal absorption rates.

The herbicides considered for use on this project can cause irritation and damage to the skin and eyes if mishandled. Eye or skin irritation would likely be the only overt effect because of mishandling these herbicides. These effects can be minimized or avoided by prudent industrial hygiene practices during handling. Worker exposure can be effectively managed through ordinary prudent practices, limiting the number of hours per day that workers are exposed to herbicide, and limiting the application rates and application methods for situations that may affect worker health. Herbicide labels indicate the personal protective equipment required for applicators. “Upper bound” hazard quotients for workers are intended to represent scenarios where workers are not following typical safety practices (SERA 2011a).

Accidental worker exposures are most likely to involve splashing a solution of herbicides into the eyes or on the skin. Two general types of exposure are modeled: one involving direct contact with a solution of the herbicide and another associated with accidental spills of the herbicide concentrate onto the surface of the skin. Exposure scenarios involving direct contact with herbicide solutions are characterized by immersing unprotected hands for 1 minute or wearing contaminated gloves for 1 hour. Workers are not likely to immerse their hands in herbicide; however, the contamination of gloves or other clothing is possible.

Exposure scenarios involving chemical spills onto the skin are characterized by a spill onto the lower legs as well as a spill onto the hands. In these scenarios, it is assumed that a solution of the chemical is spilled onto a given surface area of skin and that a certain amount of the chemical adheres to the skin. The protection provided by clothing is not included in the assessment.

The herbicides proposed for use under all alternatives have little potential to harm workers. In most cases, hazard quotient (HQ) values are below the threshold of concern (HQ values are less than 1, even given unlikely upper bound estimates). For the rates and methods that would be approved in the action alternatives, triclopyr is the one herbicide that is associated with HQ values greater than 1 for worker health. Triclopyr is not among the first-choice herbicide in any alternative.

For general worker exposure, the upper bound estimates HQ values range from 1.6 (triclopyr TEA) to 6 (triclopyr BEE). Accidental exposure to triclopyr BEE can also have impacts that are more serious to the eyes. An upper bound estimated HQ of 7 was calculated for an applicator wearing gloves saturated with triclopyr BEE for one hour.

In addition, two herbicides, picloram and clopyralid, contain an industrial by-product of the manufacturing process that is linked to cancer: hexachlorobenzene (HCB). Picloram contains a higher concentration of HCB than does clopyralid. One alternative (D) would use picloram as the first-choice herbicide for about 63 acres. A worker applying picloram at the maximum application rate, treating 112 acres in one day, and not wearing any protective clothing resulted in theoretical HCB exposure over the cancer risk threshold established by EPA. This is not plausible for this project because picloram would not be broadcast at the maximum rate (PDF F2) and personal protective equipment is required by the label. Thus, HCB exposure from this project would not increase risk of cancer to workers.

Public Herbicide Exposure Analysis

The public is unlikely to be affected by the herbicide use proposed in this project. The risk assessments provided hazard quotient estimates for accidental, operational and chronic exposure scenarios. The reference doses for a child, woman or man are conservative and account for uncertainty and sensitive populations. Few plausible scenarios exist that exceed even the most conservative threshold of concern for public health and safety. The potential for the public to be exposed to HCBs from the use of clopyralid or picloram were also considered; the use of these herbicides as proposed in this project would not result in increased cancer risk to the general public.

Accidental Scenarios

Accidental exposure is unlikely to occur. The risk assessments provide hazard quotient estimates for two types of accidental scenarios: 1) direct spray and 2) exposures from drinking water or eating fish from a pond where herbicide has been spilled. Direct spray scenarios include the exposed skin of a woman or child being directly sprayed. Spill scenarios include a child drinking out of a pond where spills have occurred, a man eating fish out of a pond where a spill has occurred, and a man from a subsistence population eating fish as a greater part of their diet from a pond where a spill has occurred. These scenarios are implausible because 1) applicators would not directly spray a person and 2) project design features limit the amount of herbicide that may be transported to daily amounts. Upper bound estimates a 200 gallon spill; this is a greater amount than would be transported on the Forest given pdf G1 that limits the amount of herbicide that may be transported each day. The central and lower bound estimates include a smaller spill (100 and 20 gallons respectively).

Direct Spray

No person is likely to be directly sprayed given the broadcast, spot, and hand/select methods proposed in the action alternatives. An HQ of 1.4 is associated with the upper bound estimate for triclopyr BEE for this scenario. No HQ values greater than 1 are associated with this scenario for any of the other herbicides, even considering upper bound estimates.

Accidental Spill Scenarios

Aminopyralid, chlorsulfuron, imazapyr, sulfometuron methyl, and metsulfuron methyl do not have HQ values that exceed 1 for any spill scenario, including a large spill of 200 gallons. HQ values are less than 1 for all herbicides proposed for use in the action alternatives for smaller spills (20 and 100 gallons respectively). None of the fish consumption scenarios for any herbicide have HQ values greater than 1 for any herbicide proposed for use in the action alternatives.

Some herbicides include upper bound HQ values greater than 1 are associated with a child drinking 1 liter of water out of a pond where 200 gallons of herbicide have been spilled. These include clopyralid (HQ =2), glyphosate (HQ = 4), imazapic (HQ = 1.9), picloram (HQ = 1), sethoxydim (HQ = 1.6) and triclopyr (both formulations are associated with an HQ of 2 for this scenario).

A spill of this magnitude is not plausible and would be avoided by applying the pdfs, specifically G1 that limit the amount of material allowed to be transported to treatment sites, and requires spill planning and response. The potential risk of human health effects from any herbicide spill into drinking water would be avoided or mitigated by appropriate spill response identified in the spill response plan, periodic equipment inspections, and carrying an emergency response kit in vehicles transporting herbicides.

Acute Exposure – Contact with Vegetation

A person could brush up against sprayed vegetation soon after herbicide is applied. Such contact is unlikely because spraying occurs during the work-week (not on weekends), and public exposure would be discouraged during and after herbicide application, through notification or signing. Contact with sprayed vegetation would not exceed a level of concern for any herbicide proposed for use in the action alternatives, even for the upper bound exposure estimates.

Eating Contaminated Vegetation or Fruit

A person could be exposed to herbicide if they eat contaminated vegetation or fruit (including berries, mushrooms, or other plants). Upper bound estimates for acute exposure assume that a person would eat about 0.01 kg of contaminated vegetation or fruit per kg of body weight. Upper bound estimates for chronic exposure assume a person eats this amount for 90 days, however the amount of herbicide residue on the vegetation or fruit would decline over time, so the doses received each day for the chronic scenarios are less than for the acute scenarios. A person is unlikely to consume this much vegetation collected from the Forest in a one-time or chronic basis. A person might eat this much fruit one time, however it is less plausible that they would eat this much for 90 days.

Central estimates assume a person eats about 0.001 kg of contaminated vegetation or fruit per kg of body weight in a day (acute) or for a 90-day period (chronic). This level of consumption is plausible, however, the likelihood a person would eat any contaminated vegetation remains low given the extent and design of the project.

Project design features include use of dye in spray mixes, public notification, posting of treatment sites, supplying information during the special forest products permitting process, and coordination with the Native American tribes. Contaminated plants would likely show obvious signs of damage over a relatively short period of time and are therefore not likely to be consumed (SERA 2007b).

With the exception of triclopyr, the risk assessments do not calculate hazard quotients greater than 1 for any acute or chronic exposures from eating contaminated vegetation or fruit at central estimates. The central estimate for triclopyr (TEA and BEE) for the acute scenario of a woman of child bearing age eating contaminated vegetation is HQ = 3.

Acute scenarios for eating contaminated vegetation exceed HQ = 1 for upper bound estimates for glyphosate (HQ = 3), sethoxydim (HQ = 1.1), and both formulations of triclopyr (HQ = 4 for fruit, 27 for vegetation). HQ values for a person eating this much vegetation for 90 days exceed 1 for upper bound estimates for chlorsulfuron (HQ = 4), clopyralid (HQ = 2), picloram (HQ = 2), and sulfometuron methyl (HQ = 4).

Aminopyralid, imazapic, imazapyr, and metsulfuron methyl are not associated with HQ values greater than 1 for any acute or chronic vegetation or fruit consumption.

These acute and chronic scenarios also approximate the effects of eating other contaminated products, such as mushrooms (Durkin and Durkin 2005).

Drinking Contaminated Water

Acute and long-term exposures from direct contact or consumption of water following herbicide application were estimated for herbicide use rates for this project using the risk assessment worksheets. Along with the accidental scenarios previously described, risks from a child drinking water from stream contaminated with herbicide residues by runoff or leaching from an adjacent herbicide application are analyzed. None of the herbicides proposed for use in the alternatives are associated with HQ values greater than 1 for acute or chronic non-accidental exposure scenarios involving drinking water.

Drinking water sources would be further protected by PDF H9. Herbicide use would not occur within 100 feet of wells or 200 feet of spring developments. Please see chapter 3.5 for information on drinking water sources.

Consuming Contaminated Fish

Acute and long-term exposure scenarios involving the consumption of contaminated fish were evaluated using the herbicide concentrations in the contaminated water scenarios described above. Acute exposure was based on the assumption that an angler consumes fish taken from contaminated water after adjacent lands were sprayed. Chronic exposures are assumed to occur over a lifetime of eating contaminated fish. Subsistence groups (e.g. Native Americans) were considered to have higher consumption rates of fish (exposure rates) than recreational anglers. Hazard quotients are less than or equal to 1 for all herbicides and exposure scenarios evaluated, including a lifetime of subsistence fishing. Please see chapters 3.5 and 3.6 for more information about potential effects to water quality and fish.

Bioconcentration (bioaccumulation) was taken into account when determining exposures and resulting dose from eating contaminated fish. Bioconcentration at first increases with the length of exposure, but eventually reaches a constant maximum level. It is measured as the ratio of the concentration in the fish compared to the concentration in the water, referred to as the bioconcentration factor (BCF). A BCF less than or equal to 1 indicates that fish excrete a chemical faster than, or as fast as, they can absorb it and therefore no bioconcentration would occur. Of the 11 proposed herbicides, three slightly exceed a BCF of 1 (chlorsulfuron has a BCF of 1.5; sethoxydim, a BCF of 7; and sulfometuron methyl, a BCF of 7).

Hexachlorobenzene has a high BCF of 2,000, ranging from 2,000 – 20,000. The 2011 risk assessment for picloram (SERA 2011) quantitatively assessed chronic risk from HCB using a BCF of 20,000 for consumption of contaminated fish by subsistence populations. The HQ for carcinogenicity was 0.4; below the level of concern; however, because it occurs at such low levels in picloram (8 parts per million) and clopyralid (less than 2.5 parts per million) the risk from bioconcentration is low. Likewise, the HQ for clopyralid is below the level of concern (clopyralid has much less HCB than does picloram).

Swimming

Another exposure scenario is for a woman swimming in a stream adjacent to a sprayed area. None of the herbicides proposed for use have an HQ value greater than 1 for this scenario.

Multiple Chemical Sensitivity

The following information was adapted from USDA 2012, Gypsy Moth Management in the United Sates, a Cooperative Approach, from public comment responses prepared by SERA.

Some people feel that they suffer from Multiple Chemical Sensitivity (MCS), which is sometimes referred to as Idiopathic Environmental Intolerances (IEI). In general, individuals with MCS report that they experience a variety of adverse effects as a result of very low levels of exposure to chemicals (including herbicides) that are generally tolerated by individuals who do not have MCS.

Forest Service risk assessments incorporate an uncertainty factor of 10 to account for sensitive individuals, which may or may not eliminate risk that an individual may suffer symptoms. However, the uncertainty factor for sensitive individuals addresses variability in tolerances within a normal population. Individuals reporting MCS assert, either explicitly or implicitly, that they are atypically sensitive. There is no current consensus on the diagnosis and cause of MCS.

Until the etiology and pathogenesis of MCS has been clarified, associated symptoms and symptom complexes cannot be entirely ruled out. The Forest Service has no way to resolve concerns for MCS at the project level.

Endocrine Disruption

The Environmental Protection Agency has recently worked to establish appropriate tests and benchmarks for endocrine disruption effects. In 2009, they released a list of pesticides (based on the high potential for human exposure) that will be tested for potential to cause endocrine disruption. Glyphosate was the only herbicide considered for use on the Malheur National Forest that was included in the initial EPA testing. Current status of these studies indicate that some tier-1 studies for glyphosate have been finished, some will not be finished until 2014, and some tier-2 studies have been ordered. Results are not yet available.

Potential effects to endocrine systems from chemicals are most often studied by evaluating toxic effects to estrogen, androgen, and thyroid hormone systems and changes in the structure of major endocrine glands (adrenal, hypothalamus, pancreas, parathyroid, pituitary, thyroid, ovary, and testis). In addition, the results of multigenerational studies can be indicative of potential endocrine disruption. Studies are lacking for most herbicides on the potential to bind to estrogen or androgen receptors. To the extent that data is available, the Forest Service risk assessments address endocrine effects for the proposed herbicides and are summarized here.

There is no evidence of direct effects to the endocrine system, nor reproductive or developmental effects from aminopyralid (SERA 2007a), chlorsulfuron (SERA 2004a), imazapic (SERA 2004c), imazapyr (SERA 2011b), metsulfuron methyl (SERA 2004d), or picloram (SERA 2011c).

One study found that chlorsulfuron produced a slight decrease in fertility index in rats in a 3-generation study when rats were fed 125 mg/kg/day, but other studies have not found adverse effects on reproductive systems (SERA 2004a).

Clopyralid, sethoxydim, and triclopyr have not been found to cause reproductive effects at doses that do not also produce direct maternal toxicity, suggesting a direct toxic effect rather than an effect to the endocrine functions (SERA 2001, 2004b, 2011c).

Additionally, for imazapyr, EPA states in their review of toxicity data that there was no evidence of estrogen, androgen and/or thyroid agonistic or antagonistic activity (US EPA/OPP 2005).

Some studies of sulfometuron methyl reported changes in rat testes, reproductive performance and in thyroid function (SERA 2004e). In specific reproductive studies with dietary exposures, there were no adverse effects to reproduction found (SERA 2004e).

Endocrine disruption and glyphosate was discussed in the updated Glyphosate Risk Assessment (SERA 2011a). SERA 2011 stated that "some recent studies raise concern that glyphosate and some glyphosate formulations may be able to impact endocrine function through the inhibition of hormone synthesis (Richard et al. 2005; Benachour et al.2007a, b), binding to hormone receptors (Gasnier et al. 2009), or the alteration of gene expression (Hokanson et al. 2007)" (*all references as cited in SERA 2011*). Evaluation of the studies indicates that endocrine disruption effects were indicated for surfactants in the formulations rather than glyphosate itself. "Most of the in vitro studies… assayed both glyphosate as well as glyphosate formulations, and most of the studies clearly indicate that the biological activity of glyphosate is less than that of glyphosate formulations" (SERA 2011). The studies that raise the most concern were from formulations not manufactured in the U.S. Based on the studies using formulations from outside the United States, "there is concern that glyphosate formulations may have an impact on these endpoints and that some of these effects could be seen under typical application conditions in the United States. In the absence of comparable studies on U.S. formulations, however, it is not clear whether the studies on glyphosate formulations used outside the United States are applicable to risks posed by U.S. formulations of glyphosate" (SERA 2011).

Additionally, there is a lack of specific information on the composition of different surfactants used in different formulations of glyphosate, as this information is identified as confidential business information. This lack of information limits the hazard identification for some toxic effects (SERA 2011). Given data limitations, the current practice of risk assessment is to use very protective exposure and dose scenarios, which are used in the 2011 glyphosate risk assessment and this analysis. Until more data on surfactants becomes available, it is not certain that assessment relies on "the most toxic surfactant in the most sensitive species" for the quantitative analysis (SERA 2011).[1]

The risk for endocrine disruption would be greatly reduced by measures such as required use of proper protective equipment, public notification, use of licensed applicators, limiting application rates and other relevant pdfs. Results of herbicide risk assessments indicate that there is no evidence to suggest that these types of effects will occur from use of the proposed herbicides.

Environmental Justice and Disproportionate Effects

The R6 2005 FEIS noted that some minority groups may be disproportionately exposed to herbicides, either because they are disproportionately represented in the pool of likely forest workers, or in the pool of special forest product or subsistence gatherers. The R6 2005 FEIS suggested that Hispanic/Latino forest workers and American Indians are minority groups that could be disproportionately affected by herbicide use. On the Malheur National Forest, Asian matsutake mushroom pickers and others who collect or use special forest products may be more likely to encounter herbicide spraying. However, minority forest workers, special forest product harvesters, and subsistence gatherers are not likely to be exposed to a dose that exceeds a threshold of concern. Pdfs requiring public and tribal notification, use of

[1] The potential for NPE based surfactants to cause endocrine disruption was discussed in the DEIS. A pdf was added to the project that eliminates use of NPE based surfactants (pdf F2). Thus, no potential for endocrine disruption from exposure to NPE surfactants would be associated with this project.

dye in spray mixes, on-the-ground signing, and restrictions on herbicide and surfactant use would reduce the potential for exposure.

Direct and Indirect Effects of Alternatives

Alternative A – No Action

No invasive plant treatments would be completed under alternative A, so there would be no effects on human health from this project.

Alternative B – Proposed Action

Workers and the public may be exposed to the herbicides used to treat invasive plants under this alternative. Few exposures exceeding a threshold of concern are predicted and adverse effects to human health are unlikely for this alternative. Table 27 lists specific pdfs in alternative B that address human health concerns. None of the first choice herbicides in this alternative are associated with HQ values greater than 1.

Table 1. Project design features in alternative B that minimize potential worker and public exposure to herbicides

PDF Reference	Project Design Feature
B1	Coordinate treatments on neighboring lands and within municipal watersheds. For neighboring lands, base distances on invasive species reproductive characteristics, and current use.
F1	Nonylphenol ethoxylate-based non-ionic (NPE) and ethoxylated fatty amine (POEA) surfactants would not be used. Vegetable oils/silicone blends that contain alkylphenol ethoxylate ingredients may be used.
F2	The least amount of a given herbicide would be applied as necessary to meet control objectives. In no case will imazapyr use exceed 0.70 lbs. a.i./ac. Broadcast application of Clopyralid, Glyphosate, Picloram, Sethoxydim, or Sulfometuron methyl will not exceed typical rates across any acre. Spot spray of triclopyr would not exceed typical rates across any acre.
F6	When herbicides are applied, a non-toxic blue dye will be used to mark treated areas.
G	**Herbicide Transportation and Handling Safety/Spill Prevention and Containment** ▪ An Herbicide Transportation and Handling Safety/Spill Response Plan would be the responsibility of the herbicide applicator. At a minimum the plan would: ▪ Address spill prevention and containment. ▪ Estimate and limit the daily quantity of herbicides to be transported to treatment sites. ▪ Require that impervious material be placed beneath mixing areas in such a manner as to contain small spills associated with mixing/refilling. ▪ Require a spill cleanup kit be readily available for herbicide transportation, storage and application (minimum FOSS Spill Tote Universal or equivalent). ▪ Outline reporting procedures, including reporting spills to the appropriate regulatory agency. ▪ Ensure applicators are trained in safe handling and transportation procedures and spill cleanup. ▪ Require that equipment used in herbicide storage, transportation and handling are maintained in a leak proof condition. ▪ Address transportation routes so that traffic, domestic water sources, and blind curves are avoided to the extent possible. ▪ Specify conditions under which guide vehicles would be required. ▪ Specify mixing and loading locations away from water bodies so that accidental spills do not contaminate surface waters. ▪ Require that spray tanks be mixed or washed further than 150 feet of surface water. ▪ Ensure safe disposal of herbicide containers. Identify sites that may only be reached by water travel and limit the amount of herbicide that may be

PDF Reference	Project Design Feature
	transported by watercraft.
H1	Follow herbicide-use buffers. Tank mixtures would apply the largest buffer as indicated for any of the herbicides in the mixture.
K1	High use areas, including administrative sites, developed campgrounds, visitor centers, and trailheads would be posted in advance of herbicide application or closed. Postings would indicate the date of treatments, the herbicide used, and when the areas are expected to be clear of herbicide residue. See also L2 for special products and M1 for cultural plants.
K2	The public would be notified about upcoming herbicide treatments via the local newspaper or individual notification, fliers, and posting signs. Forest Service and other websites may also be used for public notification.
L2	Members of the public who identify specific forest product collection areas, non-target edible or medicinal species they collect, or areas of cultural or spiritual value, will be informed about upcoming use of herbicide in the area. Specific edible or medicinal plant collection areas identified by the public would be prominently posted prior to spraying.
L4	Flyers indicating upcoming herbicide treatments and explaining the use of blue dye may be included with mushroom and special forest product collection permits, in multi-lingual formats if necessary. See section K.
M1	American Indian tribes would be notified annually as treatments are scheduled so that tribal members may provide input and/or be notified prior to gathering cultural plants. Cultural plants identified by tribes would be buffered as above for botanical species of concern; (see section I2, I3, and I4).

Alternative C

Under alternative C, compared to alternative B, there would be less use of herbicides and less risk of exposure associated with alternative C. Use of spot or selective treatments (no broadcast) would reduce the potential for vegetation or fruit to become contaminated with herbicide. Not using herbicide near streams would reduce risk of consuming contaminated drinking water or eating contaminated fish. The same project design features listed for alternative B would be implemented.

Alternative D

Under alternative D, there would be increased use of glyphosate and picloram instead of aminopyralid. About 63 acres would be treated with picloram as a first-choice herbicide and about 725 acres of glyphosate would be the first-choice herbicide under alternative D. Upper bound estimates for a child drinking out of a pond where 200 gallons of herbicide has spilled, and for eating contaminated vegetation exceed 1 for these herbicides.

Summary of Worker and Public Exposure Scenarios with HQ Values Greater than 1

Based on the risk assessment worksheets, use of herbicides in this project are associated with HQ values greater than 1 for the following exposure scenarios. In most cases, only upper bound estimates are greater than 1, indicating a very low level of risk.

Summary of Worker and Public Exposure Scenarios by Herbicide

Based on the risk assessment worksheets, use of herbicides in this project are associated with HQ values greater than 1 for the following exposure scenarios. In most cases, only upper bound estimates are greater than 1, indicating a very low level of risk.

Aminopyralid: This is a first year, first choice herbicide in all action alternatives. No worker or public exposure scenarios have HQ values greater than 1.

Clopyralid: This is not a first year, first choice herbicide in any alternative. Upper bound HQ = 2 for a child drinking from a pond where 200 gallons of herbicide have been spilled. Upper bound HQ = 2 for chronic consumption of contaminated vegetation. Both of these scenarios are implausible given the extent of this project and the pdfs.

Chlorsulfuron: This is a first year, first choice herbicide in all action alternatives. Upper bound HQ = 4 for chronic consumption of contaminated vegetation, which is an implausible scenario given the extent of the project and the pdfs.

Glyphosate: This is a first year, first choice herbicide in alternative D. Upper bound HQ = 4 for a child drinking from a pond where 200 gallons of herbicide have been spilled. Upper bound HQ = 3 for a woman eating contaminated vegetation. Both of these scenarios are implausible given the extent of the project and the pdfs.

Imazapic: This is not a first year, first choice herbicide in any alternative. Upper bound HQ = 1.9 for a child drinking from a pond where 200 gallons of herbicide have been spilled. This scenario is implausible given the extent of the project and the pdfs.

Imazapyr: This is not a first year, first choice herbicide in any alternative. No worker or public exposure scenarios have HQ values greater than 1.

Metsulfuron methyl: This is a first year, first choice herbicide in all action alternatives. No worker or public exposure scenarios have HQ values greater than 1.

Picloram: This is a first year, first choice herbicide in alternative D and it would not be used at all in alternative C. Upper bound HQ = 1 for a child drinking from a pond where 200 gallons of herbicide have been spilled. Upper bound HQ = 4 for chronic consumption of contaminated vegetation. Both of these scenarios are implausible given the extent of this project and the pdfs.

Sethoxydim: This is not a first year, first choice herbicide in any alternative. Upper bound HQ = 1.6 for a child drinking from a pond where 200 gallons of herbicide have been spilled. Upper bound HQ = 1.1 for consumption of contaminated vegetation. Both of these scenarios are implausible given the extent of this project and the pdfs.

Sulfometuron methyl: This is not a first year, first choice herbicide in any alternative. Upper bound HQ = 4 for chronic consumption of contaminated vegetation. This scenario is implausible given the extent of the project and the pdfs.

Triclopyr BEE: This is not a first year, first choice herbicide in any alternative. For workers, upper bound HQ = 6 for general exposure, and upper bound HQ = 7 for wearing saturated gloves for one hour. Upper bound exposures assume no protective clothing and improper safety practices, which is unlikely given the pdfs. Upper bound HQ = 1.4 for direct spray of a child, which is an implausible scenario. Upper bound HQ = 2 for a child drinking from a pond where 200 gallons of herbicide have been spilled and the upper bound HQ = 27 for consumption of contaminated vegetation, which are also implausible scenarios. The upper bound HQ = 4 for consumption of contaminated fruit, which is an unlikely scenario. The central HQ = 3 for consumption of contaminated vegetation, which is unlikely given the extent of the project and pdfs.

Triclopyr TEA: This is not a first year, first choice herbicide in any alternative. For workers, upper bound HQ = 1.6 for general exposure. Upper bound exposures assume no protective clothing and improper safety practices, which is unlikely given the pdfs. Upper bound HQ = 2 for a child drinking from a pond where 200 gallons of herbicide have been spilled and the upper bound HQ = 27 for consumption of contaminated vegetation, which are also implausible scenarios. The upper bound HQ = 4 for consumption of contaminated fruit, which is an unlikely scenario. The central HQ = 3 for consumption of contaminated vegetation, which is unlikely given the extent of the project and pdfs.

Comparative risk level is shown in table x. Lower risk means that HQ values are less than 1 for all exposure scenarios studied; moderate risk means that upper bound HQ values are between 1 and 10 for one or more exposure scenarios, and all central values are below 1; higher risk means that at least one central HQ value greater than one exists.

Table 2. Comparative Risk Levels for Worker and Public Health

Comparative Risk Level	Worker Health	Public Health
Low	aminopyralid; chlorsulfuron; clopyralid; glyphosate; imazapic; imazapyr; metsulfuron methyl; picloram; sethoxydim; sulfometuron methyl	aminopyralid; imazapyr; metsulfuron methyl
Moderate	triclopyr	clopyralid; chlorsulfuron; glyphosate; imazapic; picloram; sethoxydim; sulfometuron methyl
Higher	--	triclopyr

Cumulative Effects

Alternative A would not result in any cumulative effects on human health as there would be no direct or indirect effects from No Action.

The proposed use of herbicides in all action alternatives could result in multiple doses of the same or different herbicides to workers or the general public. Multiple doses are possible within the context of this project, or when combined with herbicide use on adjacent private lands or home use by a worker or member of the general public.

The risk is very small that a person would receive multiple exposures during the time period in which the herbicide remains un-metabolized in their body. The risk assessment worksheet calculations indicate a small risk from chronic exposure of some herbicides based on a woman eating contaminated vegetation for a 90-day period. HQ values exceed 1 for upper bound estimates for eating vegetation that has been sprayed with chlorsulfuron (HQ = 4), clopyralid (HQ = 2), picloram (HQ = 2), and sulfometuron methyl (HQ = 4). The likelihood of a person eating contaminated vegetation daily over a 90 day period is implausible.

Theoretically, a person could be exposed to herbicides by more than one scenario; for instance, a person could handle, and then consume sprayed berries. The cumulative impact of such cases may be quantitatively characterized by adding the HQs for each exposure scenario. An example using the herbicide glyphosate was provided in the R6 2005 FEIS Appendix Q. Glyphosate is the most used herbicide in Oregon based on Statewide Pesticide Use Reports from 2007 and 2008 (most recent data available, see Chapter 3.1.5). The R6 2005 FEIS used central exposure estimates for a woman being directly sprayed on the lower legs, staying in contact with contaminated vegetation, eating contaminated fruit, and consuming contaminated fish. This resulted in a combined (acute) HQ of 0.012. Using the updated risk assessment (2011) worksheet for the maximum application rate in Oregon, a similar calculation resulted in an HQ of 0.322 for a woman contacting then eating contaminated fruit and vegetation, still below a threshold of concern for glyphosate exposure.

Triclopyr is associated with the largest HQ values of the herbicides proposed for use in the alternatives. However, the extent of use would be too low to result in multiple exposure (triclopyr is not a first choice herbicide in any alternative) and LRMP standards restrict application methods so that multiple routes of exposure for the public are implausible .

Even if a person was exposed to herbicides in multiple ways, the herbicides are rapidly excreted or metabolized in the human body. For instance the time between dermal exposure caused by harvesting of contaminated vegetation and the subsequent eating (oral exposure) would allow the body to metabolize some of the initial dose before receiving the second dose, thus reducing the potential for a cumulative dose.

Given the protective measures in the proposed project, and the low toxicity of the proposed herbicides to humans, there is no data to support a potential cumulative effect to human health from the use of herbicides in this project.

The R6 2005 FEIS considered the potential for synergistic effects of exposure to two or more chemicals: "Combinations of chemicals in low doses (less than one tenth of RfD) have rarely demonstrated synergistic effects. Review of the scientific literature on toxicological effects and toxicological interactions of agricultural chemicals indicate that exposure to a mixture of pesticides is more likely to lead to additive rather than synergistic effects (ATSDR, 2004; U.S.EPA/ORD, 2000). Based on the limited data available on chemical combinations involving the twelve herbicides considered in this EIS, it is possible, but unlikely, that synergistic effects could occur as a result of exposure to the herbicides considered in this analysis. Synergistic or additive effects, if any, are expected to be insignificant" (R6 2005 FEIS p. 4-3).

Additional information about herbicide use on other land ownerships in Oregon and potential for cumulative effects is in Chapter 3.1.5. The ongoing and foreseeable projects and activities within the project area would not combine with this project and cause cumulative effects of concern to human health.

References

Bakke, David. 2002, 2007. Analysis of issues surrounding the use of spray adjuvants with herbicides. Unpublished report by the Forest Service Pacific Southwest Regional Pesticide Use Specialist.

Bakke, David. 2003. Human and Ecological Risk Assessment of Nonylphenol Polyethoxylate-based (NPE) Surfactants in Forest Service Herbicide Applications. Unpublished report by the Forest Service Pacific Southwest Regional Pesticide Use Specialist.

Bautista, S.L., and S.P. Bulkin. 2008. Herbicide Information Summary and Project Design Criteria Crosswalk. Forest Service Unpublished Internal Report. United States Department of Agriculture Forest Service, Region 6. Portland, OR. 36p.

Durkin and Durkin, 2005. A Note on Plausible Initial Pesticide Residues on Selected Mushrooms: Hen of the Wood, Shiitake, and Portabello. Unpublished Internal Forest Service review of residues on mushrooms and associated health risks.

Oregon Department of Agriculture. Pesticide testing and licensing website: http://www.oregon.gov/ODA/PEST/pages/licensing_index.aspx

Syracuse Environmental Research Associates (SERA), Inc. 2001. Sethoxydim [Poast] - Human Health and Ecological Risk Assessment. Fayetteville, New York. October 31, 2001.

Syracuse Environmental Research Associates (SERA), Inc. 2003a. Glyphosate Human Health and Ecological Risk Assessment. Fayetteville, New York. March 1, 2003.

Syracuse Environmental Research Associates (SERA), Inc. 2003b. Picloram - Revised Human Health and Ecological Risk Assessment. Fayetteville, New York. June 30, 2003.

Syracuse Environmental Research Associates (SERA), Inc. 2003c. Triclopyr - Revised Human Health and Ecological Risk Assessment. Fayetteville, New York. March 15, 2003.

Syracuse Environmental Research Associates (SERA), Inc. 2004a. Chlorsulfuron Human Health and Ecological Risk Assessment. Fayetteville, New York. November 21, 2004.

Syracuse Environmental Research Associates (SERA), Inc. 2004b. Clopyralid Human Health and Ecological Risk Assessment - Final Report. Fayetteville, New York. December 5, 2004.

Syracuse Environmental Research Associates (SERA), Inc. 2004c. Imazapic Human Health and Ecological Risk Assessment. Fayetteville, New York. December 23, 2004.

Syracuse Environmental Research Associates (SERA), Inc. 2004d. Imazapyr Human Health and Ecological Risk Assessment. Faytetteville, New York. December 18, 2004.

Syracuse Environmental Research Associates (SERA), Inc. 2004e. Metsulfuron Methyl Human Health and Ecological Risk Assessment. Fayetteville, New York. December 9, 2004.

Syracuse Environmental Research Associates (SERA), Inc. 2004f. Sulfometuron methyl Human health and ecological risk assessment. Fayetteville, New York. December 14, 2004.

Syracuse Environmental Research Associates (SERA), Inc. 2007a. Aminopyralid Human health and Ecological Risk Assessment. Fayetteville, New York. Jun. 28, 2007

Syracuse Environmental Research Associates (SERA), Inc. 2007b. GLEAMS Driver User Guide, Version 1.8. Fayetteville, New York.

Syracuse Environmental Research Associates (SERA), Inc. 2011a. Glyphosate Human health and Ecological Risk Assessment. Fayetteville, New York 13066-0950. March 25, 2011.

Syracuse Environmental Research Associates (SERA), Inc. 2011b. Imazapyr Human Health and Ecological Risk Assessment. Fayetteville, New York.

Syracuse Environmental Research Associates (SERA), Inc. 2011c. Picloram Human health and Ecological Risk Assessment. Fayetteville, New York 13066-0950. Sep. 29, 2011.

Syracuse Environmental Research Associates (SERA), Inc. 2011d. Triclopyr Human health and Ecological Risk Assessment. Fayetteville, New York 13066-0950. May 24, 2011.

United States Department of Agriculture, Forest Service. 1990. Land and Resource Management Plan for the Malheur National Forest and Appendices. Pacific Northwest Region. Available at: http://www.fs.usda.gov/detail/malheur/landmanagement/?cid=fsbdev3_033814.

United States Department of Agriculture, Forest Service. 2005. Pacific Northwest Region Invasive Plant Program: Preventing and Managing Invasive Plants. Final Environmental Impact Statement. Volumes I, II, and III. (R6-NR-FHP-PR-02-05). Pacific Northwest Region. Oregon (R6 2005 FEIS).

United States Department of Agriculture, Forest Service. 2005. Pacific Northwest Region Invasive Plant Program Record of Decision. Pacific Northwest Region, Portland, OR. October 2005, R6-NR-FHP-PR-02-05. 39 pp. + appendices. (R6 2005 ROD).

United States Department of Agriculture, Forest Service and Animal and Plant Health Inspection Service. 2012. Gypsy Moth Management in the United States, a Cooperative Approach - Final Environmental Impact Statement. NA-MB-01-12. Newtown Square, Pennsylvania.